INFORMATION TECHNOLOGY ARCHITECTURE

WHAT IS IT, WHY SHOULD YOU CARE, AND HOW DO YOU DO ONE?

What follows is not a definitive guide. There is a plethora of different approaches available, most are much more detailed (sometimes too detailed), and you are encouraged to review them. At the end of this guidance some helpful Web sites are listed. The objective here is to give a fairly simple explanation in plain language of the purpose of an IT Architecture and to outline one process for doing an IT Architecture, a process that has already been used by bureaus and business units within the Department of Commerce.

What is it? Briefly stated, an Information Technology (IT) Architecture is a blueprint that is developed, implemented, maintained, and used to explain and guide how an organization's IT and information management elements work together to efficiently accomplish the mission of the organization. It is essential to realize that information is a key part of an architecture – an organization may have standards for its IT hardware and software and still not have a complete and effective IT Architecture. Having an IT Architecture with specific technology and information management goals does not mean that an organization must immediately change all of its systems, etc. – part of an IT Architecture is a plan addressing how the organization will migrate to the new targets over time.

Why Should You Care? Responding to the dictates of good management as well as legislative requirements, the Department of Commerce now requires that each of its bureaus develop and implement one or more IT Architecture(s). A bureau may have one IT Architecture that covers all of its offices and business processes, or a number of IT Architectures based on distinct business processes within the bureau. Within NOAA, for example, the management of commercial fisheries could be considered one business process, while the issuance of nautical charts could be another. The Department may have a few basic requirements that all IT Architectures must contain, but aside from those, the specific contents of the Architecture are up to the bureau. Failure to develop and implement an IT Architecture will adversely affect the chances of getting funding for new IT projects or improvements to current systems, as well as hinder an organization's ability to meet customer needs efficiently (e.g., moves to electronic commerce).

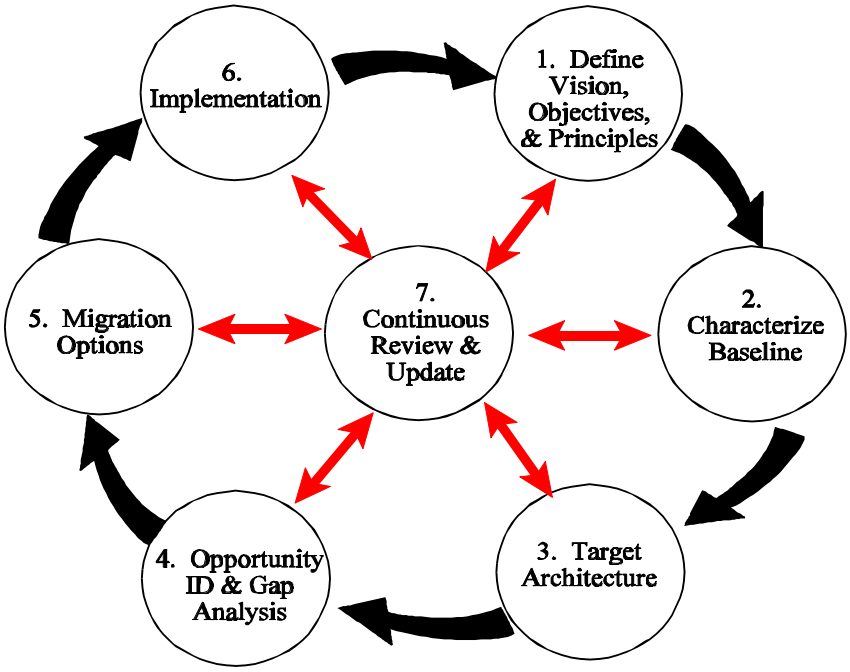
The best reasons for having an IT Architecture are the benefits it brings to your organization, and all DOC organizations who have implemented one have found it beneficial. Benefits have included the improved ability to share and efficiently process information, the ability to respond faster to changes in technology and business needs, and reductions in costs because of economies of scale and resource sharing.

How Do You Do an IT Architecture? There are risks involved in doing an IT Architecture. In larger organizations it can become a time-consuming and potentially expensive task. To minimize the risks and maximize the benefits, you need to: have a defined process to follow, understand that process well, and make sure that the process fits your situation and needs. There is no one required process - you can find a number of different ones on the Web. They do all have some things in common. When doing an IT Architecture you need to focus on: **the business activities** (work) performed, how they are organized, and where they take place; **the data sets and information flows** needed to perform the activities; **the applications and software** needed to capture and manipulate the information sets; **and the technology** (hardware, network, communications) needed to run the applications. The following pages present a seven-step process for dealing with these elements, a process that has been used successfully within the Department of Commerce.

An IT Architecture must be documented and updated as needed. The level of detail can vary - some agency architecture documents approach the size of a small set of encyclopedias, whereas others are much more compact. Examples of the documentation from some DOC bureaus and other agencies can be found at "http://www.hpcc.noaa.gov/docita." That site also contains evaluation criteria so you can know whether your efforts will meet the minimum Departmental requirements.

THE SEVEN STEP PROCESS

One approach to doing IT architectures.



STEP 1 - DEFINE YOUR VISION, OBJECTIVES, AND PRINCIPLES

Who and what are your IT Architectural efforts going to cover?
What general IT principles will guide your efforts?

Before you do anything else you need a vision of what you are trying to accomplish and some specific objectives. The vision is a statement of where the organization's IT environment and capabilities should be in the next three to five years. A key element is the issue of scope. Are you setting out to do an IT Architecture for an organization, a business operation within one organization, or a business operation that involves multiple organizations? There are trade-offs in the scope chosen for an IT Architecture; a smaller scope allows the Architecture to be tailored to very specific program needs and is easier to develop, while a broader scope realizes greater benefits in interoperability, procurement and support cost savings, and efficient information flows. You need to take resources into account when defining your objectives.

A question that may need to be asked is whether you should seek to do a complete IT Architecture or focus on a specific aspect of an Architecture. Usually it is a good idea to do a complete IT Architecture, but in some cases an aspect of the organization or business process needs action immediately. You may need to concentrate on a single process rather than completing each step for the entire organization. The objective, after all, is to improve the products and services provided to the public, not produce an IT Architecture for Architecture's sake. A complete Architecture should almost always improve the business process, but if slicing the job differently produces quicker benefits, then that should be considered.

Another first step should be a set of IT Architectural Principles – statements of preferred direction or practice on how the organization or process will use IT. These can help to provide a context for specific architectural decisions made later in the process and also help to make those decisions consistent. Some may seem so obvious that you first question why you should bother, but by documenting Principles and keeping them as a visible part of the process they are less likely to be overlooked.

There can be a wide variety of IT Principles dealing with the basic IT Architecture itself, the use of a common user interface, the use of modular components for systems, and so on. There isn't room in a brief guide like this to go into more detail, but you should review some examples done by other offices to help you focus on what should be done. The DOC IT Architecture Affinity Group has provided examples on its Home Page at http://www.hpcc.noaa.gov/docita or the group can make examples available to you upon request.

When defining your vision, objectives, and principles, you need to make sure that they are consistent with the goals of your Strategic Plan and Strategic IT Plan, as well as with the Departmental goal of achieving a "Digital Department".

STEP 2 - CHARACTERIZE YOUR IT BASELINE

How does your office do its business, what Information Technology is used, and how is it used?

The next step in the IT Architecture process is to characterize what your current status is. This means that at a given time you take a snapshot of your existing IT capabilities. The word "characterize" is used because it isn't usually necessary to identify and analyze everything IT or information-related in the organization. You just need enough data to understand the basic situation you are in and the problems that exist, and to develop an idea of where you want to go. The scale of this task depends, of course, on the size and complexity of the organization. It can vary from a relatively simple job to a complex and time-consuming one.

It is essential to remember that an IT Architecture isn't just deciding on a computing platform, an operating system, etc. Your organization exists to provide some product or service, and IT is a tool to do that. So the question is whether IT is being used in the most effective way to accomplish the organization's program goals. To determine that, you need to know a lot more than just what equipment and software you are now using. If you don't know enough to evaluate whether the work processes should be re-engineered or not, then you don't know enough to do a complete IT Architecture. The types of information you need can be placed into a number of categories. The following are just examples – different organizations choose different ways of characterizing their baseline, but these give an idea on one approach.

What Work is Performed? You must have a clear understanding of what work the organization performs and where it is performed (anywhere from one small location to throughout the nation).

What Information is Needed for that Work and by Whom? You need to understand the basic flow of information, not just within your organization but also to and from outside customers or suppliers, and how that information is organized.

What Applications are Used to Process that Information? What software is used to process, analyze, move, etc., the needed information? What protocols are involved in transfers?

What Technology is Used to Perform the Work? What IT hardware is currently used, including telecommunications and networking equipment?

Many have found that besides inventorying these things it can be very helpful to interview key IT staff, end-users, and managers; these are the people who usually know the most about what actually takes place, where problems may exist, and where opportunities for improvements may exist. You need to compile all the information that you find and then organize the data into your baseline document.

While you may collect the information in categories like those above, by the end of the process you need to know how they all inter-relate. What depends upon what? Once you have a good understanding of your current situation you are ready to move to the next step.

STEP 3 - CREATE A TARGET ARCHITECTURE

What do you want your IT Architecture to look like in the future?

At this point in the process you should know where you currently stand. Now you need to try to figure out where you would like to be (or need to be) in the future. How should the workflow ideally work? What generic types of applications and technology would be used? You are developing a model of the IT structure, not identifying the specific standards for products to be used (later you will create standards and guidelines that will be used by the organization for the acquisition of technology, applications, and services, but those are not the Target Architecture itself). To do this step effectively you must first understand the forces that are driving the need for change – the "drivers" in the business and technology areas.

Business drivers are ones telling you that you need to do business differently. Customers may be demanding better or different services. Organizations that you work with may want to change how you exchange data. The methods now used to do business may not be cost efficient in the future. Or the drivers may be instructions from higher-level organizations or from laws. As part of the Federal government, all agencies need to consider the impact of the Paperwork Elimination Act on their future IT Architecture. This law says that by a certain date the public must be given the option to transact business with the government by electronic means, and that means that agencies will need to have digital signature procedures in place. This is part of the larger push towards electronic commerce. Within the Department of Commerce, the goals of your Strategic Plan and of a "Digital Department" are similar and related drivers that must be taken into account.

Technology drivers are ones that tell you that technology is giving or will give you options for doing things differently (and hopefully better). Many parts of the Department of Commerce, for instance, realized the potential of the Internet and started using it to provide products and services to the public long before any outside forces told them that they should do this. What other technologies are out there that may provide you with similar future opportunities?

By analyzing these drivers and your current baseline, you can start to define your future business and technology models – how you see the future business process working, the general technological tools needed to make that process effective, and how those tools need to interrelate. You may then break down these models into more specific models dealing with specific areas (e.g., they could be data models, system models, infrastructure models), depending upon the complexity of the organization or process involved. In the final analysis you get down to identifying specific approaches the organization should take in the future.

The Target Architecture is the heart of the process. The four components (business activities, data sets and information flows, applications and software, and technology) of the IT Architecture

need to be modeled separately. The process consists of defining each set of architectural components and its key attributes. The desired capabilities of and relationships between components are then defined. The result is an organized set of definitions and models from which drawings can be made to reflect the different views of the architecture. Again, the relative complexity of the situation will determine how detailed and extensive this effort and documentation needs to be. The four components are then synthesized into a comprehensive Target Architecture.

The Target Architecture should be looking 3-5 years ahead. Because it is a model that does not designate specific products, it can look this far into the future. New technology will often affect specific standards for an Architecture, but these changes would not normally affect the model of how the technology elements support the business.

It is a good idea to develop an "evolvable" IT Architecture. Obviously technology changes almost daily – you need a structure that can accommodate these changes as easily as possible. Some rules for evolvable systems architectures also apply to broader enterprise architectures: keep things modular, have well-defined boundaries between systems and components (crisp interfaces), use industry-standard interfaces, use open-systems standards, and use common mechanisms whenever possible. Planning for modular systems with clear boundaries allows you to change portions of the IT Architecture without having to revise everything in the Architecture, and also helps you see how changes in one part of the Architecture may affect other elements.

Depending upon the size and complexity of the organization, all of this can produce a confusing quantity of data. There is no standard way to organize and display this data. You can look at examples of what others have done and choose the methods most useful for your particular situation and needs.

STEP 4 - DETERMINE THE GAPS BETWEEN YOUR CURRENT AND TARGET ARCHITECTURES

What are the differences between your baseline and the architecture you want to achieve?

So by this time you should know where you are now and where you want to be at some point in the future. It is time to evaluate how long that road is. How far is the organization from the target?

The gaps have to be identified for each component of the IT Architecture. Where are the gaps large and where are they small? How difficult will it be to bridge those gaps? How much time, money, resistance from users, etc., may be involved? The nature of your organization plays a great role in this analysis. A smaller centralized organization or one where IT is controlled by one office will face different issues than a decentralized office with little or no central IT control. There may be gaps that are theoretically easy to solve - say a change with no complicated shift in technology and that will actually save money immediately – but that would face such fierce

resistance by users that the organization would decide that there is a large and difficult gap here, with difficult decisions as to whether and how to bridge that gap.

Knowledge of all this is necessary to go to the next step – developing the game plan for migrating to the Target Architecture.

STEP 5 - DEVELOP A MIGRATION PLAN

How will you bridge the gaps between the baseline and the Target Architecture?

You now know your baseline, your Target Architecture, the gaps between the two, and the issues involved in bridging those gaps. The next step is to plan for when and how you are going to actually do that bridging.

Many factors are involved, including those that you looked at in the gap analysis. Are there "quick wins" where the organization can realize benefits right away and for a minimal cost and effort? Besides the immediate benefits, these can show doubters the value of an IT Architecture. Or are the real problems ones that need immediate concentration on more major and long-term tasks? Which actions depend upon other actions to be effective? In some cases at least an informal cost-benefit analysis may be needed.

There are no standard answers here, other than that you need to do the analysis and make a plan setting priorities for implementation. If possible, a timetable should also be created, recognizing that budget considerations can have a major impact on that schedule. In some cases the hardest question may be who will do the work – who will be responsible for doing what, and how? A plan without assigned responsibilities rarely produces anything. So if a contractor develops an IT architectural document for you, and it is placed on a shelf, you probably wasted your money.

In many instances a key tool for migration is something called a "Technical Reference Model", or TRM. A TRM can generically identify the various software, hardware, and interfaces needed for the organization or business operation, and then identify acceptable options within the IT Architecture for filling these needs. These options are specific types of equipment, software products, protocols, etc. There may be a single standard for some elements and a range of acceptable options for others. It is important to be aware of situations where higher-level organizations or outside business needs may constrain your choices, such as where a higher organization level has already defined a standard for something throughout the organization. The TRM helps you see how everything fits together, guides the acquisition of IT products and services towards your Target Architecture, and helps provide a base for future architectural changes. A separate Standards Profile is often created to aid in guiding acquisitions and application development. An example TRM from the Patent and Trademark Office is available from the Web site at "http://www.hpcc.noaa.gov/docita."

Another key part of the plan is identifying the processes to be used for implementation. In a large organization what process will be used to ensure that procurements are consistent with the Target

Architecture or TRM, or that non-compliance is acceptable for some specific situation? In short, how will standards be enforced and by whom?

The planned migration approach developed should be reflected in your Operational IT Plans.

STEP 6 - IMPLEMENT THE MIGRATION PLAN AND ARCHITECTURE

Start implementing the plan to bridge the IT architectural gaps.

Obviously the steps leading up to this one will be of limited value if implementation never takes place. But what does "implementation" really mean? It does not necessarily mean that the organization must immediately convert its IT and information systems to the Target Architecture. If the IT Architecture is guiding the procurement and development of technology and systems, then it **is** being implemented, even if it may take a number of years before the Target Architecture's goals are fully realized.

As mentioned above in Step 5, a migration plan can identify priorities where the application of the organization's available resources and time can produce the greatest benefits.

STEP 7 - REVIEW AND UPDATE REGULARLY

An IT Architecture is a process, not a document.

Obviously technology is changing very quickly these days, and that trend doesn't appear likely to slow down or stop. Business needs and processes also change over time. So a Target Architecture, whether fully implemented or not, that addresses how IT and information will serve business needs must be periodically reviewed and updated to reflect those changes.

The review can affect any of the other six steps identified – important technology or business changes may require a new vision and new basic objectives. New technology may provide opportunities for a revised Target Architecture, and you may need to re-evaluate your baseline to allow you to identify the gaps that need to be spanned to reach that new target. If architectural documents remained unchanged the chances are increasingly high over time that the organization isn't maximizing the possible value of new technology and is restricting creativity.

Ideally at least annual updates should reflect changes in strategic plans and budget status. Since a good IT Architecture deals with interfaces with other organizations, you also need to stay aware of technological changes in those organizations and make sure that they are aware of changes that you may be planning to make.

ANOTHER LOOK AT THE PROCESS

The Federal CIO Council (CIO means "Chief Information Officer") has developed a conceptual framework for a Federal Enterprise Architecture. The following graphic comes from one of their publications. As you can see, some of the terms are different than the ones used above, but the basic approach is consistent. Details and definitions can be found at their Web site (the URL is http://www.itpolicy.gsa.gov/mke/archplus/cmodel.htm).

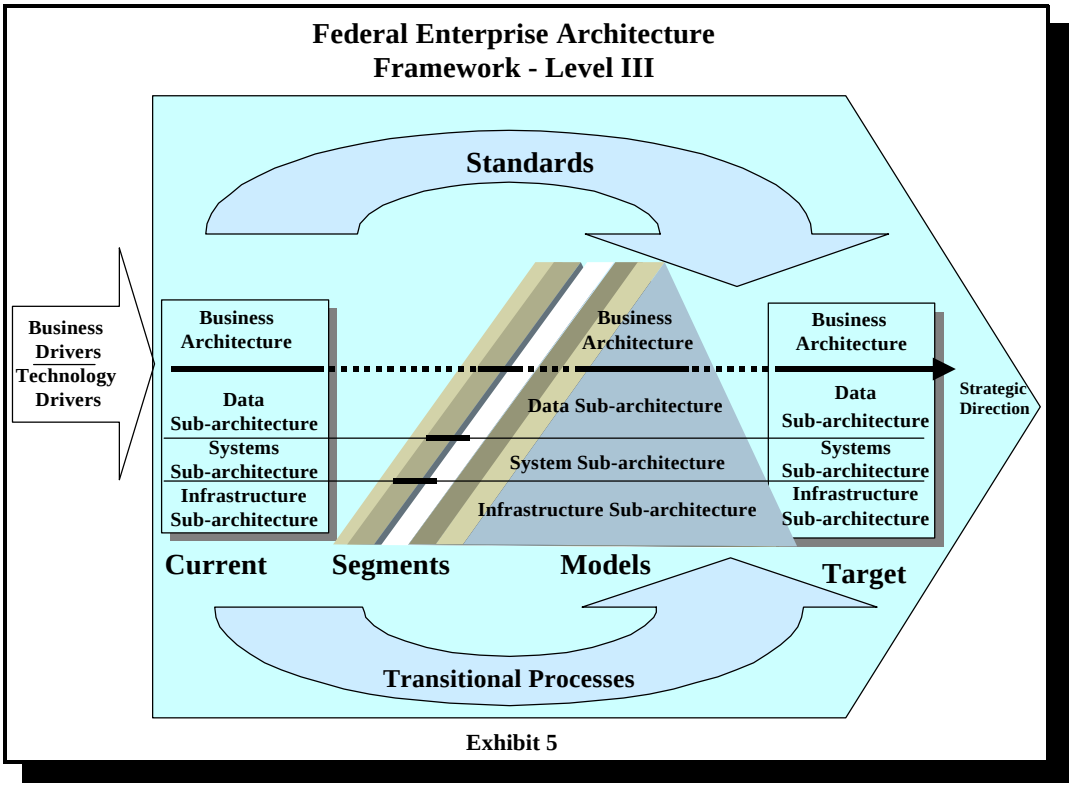


Exhibit 5

USEFUL WEB SITES

http://www.hpcc.noaa.gov/docita - This is a site maintained by the Department of Commerce IT Architecture Affinity Group.

http://www.itpolicy.gsa.gov/mke/archplus/archhome.htm - The "Architecture Plus" site from GSA.

http://www-library.itsi.disa.mil/tafim/tafim3.0/pages/tafim.htm - This is the Department of Defense Technical Architecture Framework for Information Management (TAFIM). It has served as a guide for other organizations, but be warned that it is a very large document.